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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is included. (AG)

ED 059290

S-12R

June 1970

U.S. Training and
Employment Service
Technical Report
S-12R

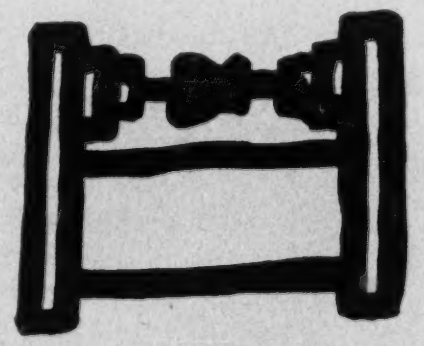
Development of USTES

APTITUDE TEST
BATTERY FOR

MACHINIST

(mach. shop.) I
600.280

U.S DEPARTMENT OF LABOR
Manpower Administration



TM 001 181

Technical Report on Development of USTES Aptitude Test Battery For . . . . . .

Machinist (mach. shop) I 600.280

S-12R

(Developed in Cooperation with the Michigan,
Washington and Wisconsin State Employment Services)

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June 1970

FOREWORD

The United States Training and Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

GATB Study#681, 726, and 2731

Development of USTES Aptitude Test Battery

For

Machinist (mach. shop) I 600.280-030

S-12R

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupation of Machinist (mach. shop) I 600.280-030. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB Scores
N-Numerical Aptitude	80
S-Spatial Aptitude	80
M-Manual Dexterity	80

Research Summary-Validation Sample

Sample:

71 male workers employed as Machinists in Centerline, Michigan. This study was conducted prior to the requirement of providing minority group information. Therefore, minority group status is unknown.

Criterion:

Supervisor's ratings.

Design:

Concurrent (test and criterion data were collected at approximately the same time).

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations, and selective efficiencies.

Concurrent Validity:

Phi coefficient = .36 ($P/2 < .005$)

Effectiveness of Norms:

Only 65% of the nontest-selected workers used for this study were good workers; if the workers had been test-selected with the S-12R norms, 76% would have been good workers. Thirty-five percent of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with the S-12R norms, only 24% would have been poor workers. The effectiveness of the norms is shown graphically in Table 1:

Table 1

Effectiveness of Norms

	Without Tests	With Tests
Good Workers	65%	76%
Poor Workers	35%	24%

SAMPLE DESCRIPTION

Size:

N = 71.

Occupational Status:

Employed workers.

Work Setting:

Workers were employed at the Detroit Tank Arsenal, Centerline, Michigan.

Employer Selection Requirements:

Previous Experience: Applicants must have completed a four-year apprenticeship as a machinist or must have had four years of practical experience in the trade, sufficient in content and progressive acquirement of trade skills to be the substantial equivalent of a completed apprenticeship.

Principal Activities:

The job duties for each worker are comparable to those shown in the Appendix.

Minimum Experience:

Workers in the sample had at least one year of experience beyond the Apprenticeship requirement.

TABLE 2

Means (M), Standard Deviations (SD), Ranges, Pearson Product-Moment Correlations with the Criterion (r) for Age, Education and Experience.

	Mean	SD	Range	r
Age (years)	35.3	8.9	24-65	-.165
Education (years)	11.0	1.7	7-16	-.009
Experience in plant (months)	38.6	33.2	2-180	.198
Total Experience (months)	115.0	85.2	12-480	-.132

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1001 were administered during January 1952. The B-1001 scores have been converted to equivalent B-1002 scores.

CRITERION

The criterion data consisted of alternating rank order ratings (i.e. 1st highest, 1st lowest; 2nd highest, 2nd lowest, etc.) from four supervisors. Each group of four ratings were divided into the top 25%, middle 50%, and lowest 25% and combined into groups of A, B, and C. These groups were then converted to numerical values of 63, 50, and 37 respectively to allow for the computation of Pearson product-moment correlation coefficient. Broad category ratings were used since it would not be reasonable to assume exact comparability of the four supervisors' ratings.

Criterion Dichotomy:

The criterion distribution was dichotomized into low and high groups by placing 35% of the sample in the low group to correspond with the percentage of workers considered unsatisfactory or marginal. This was done by converting the rank order ratings of each foreman into linear scores which were combined into one distribution. Workers in the high group were designated as "good workers" and those in the low group as "poor workers." The criterion critical score is 43.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitudes N and M which do not have high correlations with the criterion were considered for inclusion in the norms because the qualitative analysis indicated th at Aptitude N is important to the job duties and Aptitude M is critical to the job duties. Aptitude N also had a relatively high mean score and a relatively low standard deviation for the sample. With employed workers a relatively high mean score may indicate that some sample pre-selection has taken place. A relatively low standard deviation may also indicate some sample pre-selection. Tables 3, 4, and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis
(Based on the job analysis, the aptitudes indicated appear to be important to the work performed)

Aptitude	Rationale
G - General Learning Ability	Required in all phases of the machinist's work requiring judgment, such as planning the type of machine to be used, operational setup to be made and sequence of operations to be performed.
N - Numerical Aptitude	Involved in the work done by the machinist in making layouts and setups of jobs which require the application of general shop mathematics, including geometry and trigonometry, and in checking the work that is in progress for conformance to specifications.
S - Spatial Aptitude	Involved in such duties as working from blueprints and sketches, making layouts, and in inspecting work upon completion for compliance with shop orders and drawings.
M - Manual Dexterity	Required in such duties as setting the work on the surface plate, mounting the tools and work, and setting machine feeds.

TABLE 4

Means (M), Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB: N = 71.

	Mean	SD	Range	r
G - General Learning Ability	103.3	15.1	58-132	.288*
V - Verbal Aptitude	98.9	15.5	67-133	.161
N - Numerical Aptitude	100.5	12.8	68-130	.183
S - Spatial Aptitude	109.2	18.2	70-149	.362**
P - Form Perception	98.5	18.7	59-142	.274*
Q - Clerical Perception	90.0	14.4	59-123	.302*
K - Motor Coordination	90.6	19.4	49-142	.075
F - Finger Dexterity	93.1	22.4	42-144	-.017
M - Manual Dexterity	99.1	22.0	43-142	.077

*Significant at the .05 level.
**Significant at the .01 level.

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	X		X	X					X*
Irrelevant									
Relatively High Mean	X		X	X					
Relatively Low Standard Dev.			X						
Significant Correlation With Criterion	X			X	X	X			
Aptitudes to be Considered for Trial Norms	G		N	S	P	Q			M*

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of aptitudes G, N, S, P, Q, and M at trial cutting scores were able to differentiate between the 65% of the sample considered to be good workers and the 35% of the sample considered to be poor workers. Trial cutting scores at five-point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For two-aptitude norms, minimum cutting scores slightly higher than one standard deviation below the mean will eliminate about one-third of the sample; for four-aptitude trial norms, cutting scores slightly lower than one standard deviation below the mean will eliminate about one-third of the sample. The phi coefficient was used as the basis for comparing trial norms. The optimum differentiation for the occupation of Machinist (mach. shop) I 600.280-030 was provided by norms of N-80, S-80 and M-80. The validity of these norms is shown in Table 6 and is indicated by a phi coefficient of .36 (statistically significant at the .005 level).

TABLE 6

Concurrent Validity of Test Norms
N-80, S-80 and M-80

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Workers	7	39	46
Poor Workers	13	12	25
Total	20	51	71

Phi coefficient = .36

Chi square (X_y^2) = 9.1

Significance level = $P/2 < .005$

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirement for incorporating the occupation studied into OAP-37 which is shown in the 1970 edition of Section II of the Manual for the General Aptitude Test Battery. A Phi coefficient of .34 is obtained with the OAP-37 norms of N-80, S-95, and M-85.

S-12R

GATB #726

CHECK STUDY RESEARCH SUMMARY SHEET

Machinist (mach. shop) I 600.280-030

Check Study #1 Research Summary

Sample:

Forty male machinist students at the Vocational and Technical Schools in Tacoma and Spokane Washington. This study was completed prior to the requirement of providing minority group composition. Therefore, minority group composition is unknown.

TABLE 7

Means (M), Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education and the Aptitudes of the GATB-Cross-Validation Sample #1.

	Mean	SD	Range	r***
Age (years)	21.5	7.0	16-43	.408**
Education (years)	11.1	1.9	8-16	.355*
G - General Learning Ability	102.7	16.8	67-126	.601**
V - Verbal Aptitude	92.8	15.8	58-118	.501**
N - Numerical Aptitude	95.0	18.7	48-120	.619**
S - Spatial Aptitude	116.8	16.3	83-145	.345*
P - Form Perception	102.8	16.9	73-133	.160
Q - Clerical Perception	86.8	14.1	62-120	.295*
K - Motor Coordination	91.0	15.3	58-123	.253
F - Finger Dexterity	101.8	20.8	55-141	.126
M - Manual Dexterity	100.8	18.0	47-131	.067

*Significant at the .05 level.
**Significant at the .01 level.
*** Corrected for broad categories

Criterion:

Instructors' ratings.

Design:

Longitudinal (sample was tested before training and criterion data collected upon the completion of training in 1952).

Principal Activities:

The job duties of the occupation for which the students are being trained are comparable to those shown on the Fact Sheet.

Predictive Validity:

Phi coefficient = .58 ($P/2 < .0005$)

Effectiveness of Norms:

Only 68% of the nontest-selected students used for this study were good students; if the students had been test-selected with the S-12R norms, 84% would have been good students. Thirty-two percent of the nontest-selected students used for this study were poor students; if the students had been test-selected with the S-12R norms, only 16% would have been poor students. The effectiveness of the norms is shown graphically in Table 8:

TABLE 8

Effectiveness of S-12R Norms
on Check Study #1 Sample

	Without Tests	With Tests
Good Students	68%	84%
Poor Students	32%	16%

TABLE 9

Predictive Validity of S-12R Norms
N-80, S-80, and M-80
on Check Study #1 Sample

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Students	1	26	27
Poor Students	8	5	13
Total	9	31	40

Phi coefficient = .58 Chi square (X^2_y) = 13.7
Significance level = $P/2 < .0005$

S-12R GATB #2731

CHECK STUDY RESEARCH SUMMARY SHEET

Machinist (mach. shop) I 600.280-030

Check Study #2 Research Summary

Sample:

Sixty-six male MDTA-OJT trainees in Madison, Wisconsin, who completed a 1 year OJT training program. This study was begun before the requirement of providing minority group information. Therefore, minority group composition is unknown.

TABLE 10

Means (M), Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the multiple-hurdle criterion of Descriptive Rating Scale (r^1) and Blue Print Reading (r^2) for Age, Education, and Aptitudes G,N,S, and M of the GATB; N =66.

	Mean	SD	Range	(r^1)	(r^2)
Age (years)	23.8	4.4	19-39	.172a	.054a
Education (years)	11.8	1.1	8-14	.303**a	.201a
G - General Learning Ability	106.0	12.7	75-132	.418**	.368**
N - Numerical Aptitude	106.3	13.0	67-134	.431**	.435**
S - Spatial Aptitude	107.5	19.0	65-147	.275*	.184
M - Manual Dexterity	117.8	17.2	80-150	.242*	.187

a - N = 46
*Significant at the .05 level.
**Significant at the .01 level.

Criterion:

Multiple-hurdle criterion consisting of supervisory ratings on modified Descriptive Rating Scale and company Blue Print Reading Scores.

Design:

Longitudinal (tests were administered prior to one year training program and the criterion data obtained after last trainees had completed their training in 1968.)

Principal Activities:

The job duties of the occupation for which the trainees are being trained are comparable to those shown in the job description in the Fact Sheet.

Predictive Validity:

Phi coefficient (Ø) .42

Effectiveness of Norms:

Only 74% of the nontest-selected trainees used for this study were good trainees; if these trainees had been test-selected with the S-12R norms, 81% would have been good trainees. Twenty-six percent of the nontest-selected trainees were poor trainees; if the trainees had been test-selected with the S-12R norms only 19% would have been poor trainees. The effectiveness of the norms is shown graphically in Table 11:

TABLE 11

Effectiveness of Norms

on Check Study #2 Sample

	Without Tests	With Tests
Good Trainees	74%	81%
Poor Trainees	26%	19%

TABLE 12

Predictive Validity of S-12R Norms
N-80, S-80, and M-80
on Check Study #2 Sample

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Trainees	1	48	49
Poor Trainees	6	11	17
Total	7	59	66

Phi coefficient (Ø) = .42 Chi square (X^2) = 11.4

Significance level = $P/2 < .0005$

June 1970 S-12R

FACT SHEET

Job Title:

Machinist (mach. shop) I 600.280-030

Job Summary:

Performs machining work, including layout, setup, operations on various machines and inspection of completed work on a variety or metal items.

Work Performed:

Studies shop orders and drawings. Determines nature of operations to be performed and plans type of machine (or machines) to be used, operational setup (or setups) to be made, and sequence of operations to be performed.

Makes lay-out of work (if nature of operations to be performed requires) sets work on surface plate and establishes necessary lines and location points using punches, scribers, vernier, calipers, dial indicators, micrometers, surface gages, dividers, height gage, etc., applying knowledge of general shop mathematics (including geometry and trigonometry) as required.

Selects machine to perform operations (engine lathe, milling machine, radial drill, sensitive drill press, grinder and shaper). Selects standard cutting tools from crib and grinds to proper shape. Mounts tool (grinding wheel or cutter) into machine. Mounts work into machine using chucks, vises, face plates, between centers and improvises where necessary due to lack of jigs and fixtures. Sets machine feeds and speeds, places machine under power and performs operation either feeding by hand and/or using automatic feed. Checks work during operation using micrometers, scales feeler gages, calipers, etc. Changes set-up and cutting tool (or grinding wheel) and performs additional operations on the same machine or takes work on to other machines, performing set-up and operation through to completion.

Inspects work on completion for compliance with shop order and drawing. Refers completed work (which may consist of one part or several parts) to supervisor. Frequency of operation of the different type machines (or cycle) in performance of the various machining operations is determined by overall manufacturing division work load and priorities placed on the different jobs. Ordinarily cycle will be completed in one year.

Works with cast iron, aluminum, bronze, high speed steel, carbon steel, mild steel and armor plate. Performs turning, boring, drilling, grinding, milling, tapping, shaping, and threading in arriving at various angles, radii, contour types, and linear dimensions. Tolerances worked to on the majority of operations vary from fractional tolerances 1/64" to .001". Performs machining on tank and automotive parts, automotive field service items, fixtures, tool and gage parts, etc. Diversity of work comparable to shop.

Responsible for completion of assigned projects, however, receives assistance from supervisor as required in set-up or machining (determination of type setup, type holding device and type cutter or grinding wheel) where tolerances worked to are closer than .001. Refers questions to supervisor regarding discrepancies found on shop orders and drawings.

Effectiveness of Norms:

Only 65% of the nontest-selected workers in the validation sample were good workers; if the workers had been test-selected with the S-12R norms, 76% would have been good workers. Thirty-five percent of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with the S-12R norms, only 24% would have been poor workers.

Only 68% of the nontest-selected students in Check Study #1 were good students; if the students had been test-selected with the S-12R norms, 84% would have been good students. Thirty-two percent of the nontest-selected students used for this study were poor students; if the students had been test-selected with the S-12R norms, only 16% would have been poor students.

Only 74% of the nontest-selected trainees in Check Study #2 were good trainees; if the trainees had been test selected with the S-12R norms, 81% would have been good trainees. Twenty-six percent of the nontest-selected trainees used for this study were poor trainees, if the trainees had been test selected with the S-12R norms, only 19% would have been poor trainees.

Applicability of S-12R Norms:

The aptitude test battery is applicable to jobs which include a majority of duties described above.

GPO 898.739

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